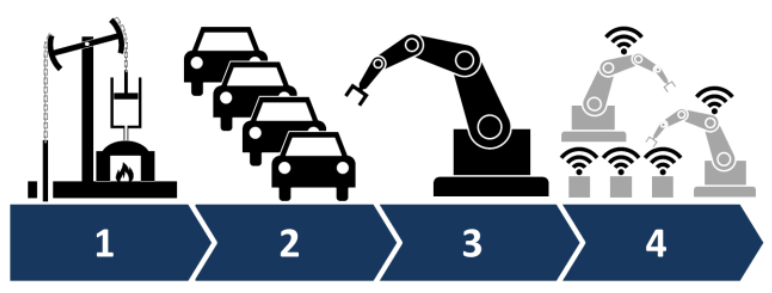
Industry 4.0

First came steam and the first machines that mechanized some of the work our ancestors did. Next was electricity, the assembly line and the birth of mass production.  The third era of industry came about with the advent of computers and the beginnings of automation, when robots and machines began to replace human workers on those assembly lines.

And now we enter Industry 4.0, in which computers and automation will come together in an entirely new way, with robotics connected remotely to computer systems equipped with machine learning algorithms that can learn and control the robotics with very little input from human operators.

Industry 4.0 introduces what has been called the “smart factory,” in which cyber-physical systems monitor the physical processes of the factory and make decentralized decisions. The physical systems become Internet of Things, communicating and cooperating both with each other and with humans in real time via the wireless web.

For a factory or system to be considered Industry 4.0, it must include:

* Interoperability — machines, devices, sensors and people that connect and communicate with one another.
* Information transparency — the systems create a virtual copy of the physical world through sensor data in order to contextualize information.
* Technical assistance — both the ability of the systems to support humans in making decisions and solving problems *and* the ability to assist humans with tasks that are too difficult or unsafe for humans.
* Decentralized decision-making — the ability of cyber-physical systems to make simple decisions on their own and become as autonomous as possible.

But as with any major shift, there are challenges inherent in adopting an Industry 4.0 model:

* Data security issues are greatly increased by integrating new systems and more access to those systems. Additionally, proprietary production knowledge becomes an IT security problem as well.
* A high degree of reliability and stability are needed for successful cyber-physical communication that can be difficult to achieve and maintain.
* Maintaining the integrity of the production process with less human oversight could become a barrier.
* Loss of high-paying human jobs is always a concern when new automations are introduced.
* And avoiding technical problems that could cause expensive production outages is always a concern.

Additionally, there is a systemic lack of experience and manpower to create and implement these systems — not to mention a general reluctance from stakeholders and investors to invest heavily in new technologies.

But the benefits of an Industry 4.0 model could outweigh the concerns for many production facilities. In very dangerous working environments, the health and safety of human workers could be improved dramatically.  Supply chains could be more readily controlled when there is data at every level of the manufacturing and delivery process. Computer control could produce much more reliable and consistent productivity and output.  And the results for many businesses could be increased revenues, market share, and profits.

Reports have even suggested that emerging markets like India could benefit tremendously from Industry 4.0 practices, and the city of Cincinnati, Ohio has [declared itself](http://www.imscenter.net/IMS_news/cincinnati-mayor-proclaimed-cincinnati-to-be-industry-4-0-demonstration-city)an “Industry 4.0 demonstration city” to encourage investment and innovation in the manufacturing sector there.

The question, then, is not *if* Industry 4.0 is coming, but *how quickly*. As with big data and other business trends, I suspect that the early adopters will be rewarded for their courage jumping into this new technology, and those who avoid change risk becoming irrelevant and left behind.

(<https://www.forbes.com/sites/riverbed/2018/03/14/leveraging-software-defined-technology-to-drive-a-successful-infrastructure-refresh/#31c5d8ed2173>)

### What is Industry 4.0?

From smartphones to smart fridges, technology has played a major role in advancing most areas of our everyday lives - but it is also transforming the world of industry. Industry 4.0 is the label given to the gradual combination of traditional manufacturing and industrial practices with the increasingly technological world around us.This includes using large-scale M2M and Internet of Things (IoT) deployments to help manufacturers and consumers alike provide increased automation, improved communication and monitoring, along with self-diagnosis and new levels of analysis to provide a truly productive future.

(https://www.techradar.com/news/what-is-industry-40-everything-you-need-to-know)

Factories will become increasingly automated and self-monitoring as the machines within are given the ability to analyse and communicate with each other and their human co-workers, granting companies much smoother processes that free up workers for other tasks.

What is Industry 4.0? The meaning of the term and main features The term “Industrie 4.0” was initially coined by the German government. It describes and encapsulates a set of technological changes in manufacturing and sets out priorities of a coherent policy framework with the aim of maintaining the global competitiveness of German industry. It is conceptual in that it sets out a way of understanding an observed phenomenon and institutional in that it provides the framework for a range of policy initiatives identified and supported by government and business representatives that drive a research and development programme. Industry 4.0 describes the organisation of production processes based on technology and devices autonomously communicating with each other along the value chain: a model of the ‘smart’ factory of the future where computer-driven systems monitor physical processes, create a virtual copy of the physical world and make decentralised decisions based on self-organisation mechanisms. The concept takes account of the increased computerisation of the manufacturing industries where physical objects are seamlessly integrated into the information network. As a result, “manufacturing systems are vertically networked with business processes within factories and enterprises and horizontally connected to spatially dispersed value networks that can be managed in real time – from the moment an order is placed right through to outbound logistics.” These developments make the distinction between industry and services less relevant as digital technologies are connected with industrial products and services into hybrid products which are neither goods nor services exclusively. Indeed, both the terms ‘Internet of Things’ and ‘Internet of Services’ are considered elements of Industry 4.0.

The main features of Industry 4.0 are:   
• Interoperability: cyber-physical systems (work-piece carriers, assembly stations and products) allow humans and smart factories to connect and communicate with each other.   
• Virtualisation: a virtual copy of the Smart Factory is created by linking sensor data with virtual plant models and simulation models.   
• Decentralisation: ability of cyber-physical systems to make decisions of their own and to produce locally thanks to technologies such as 3d printing.   
• Real-Time Capability: the capability to collect and analyse data and provide the derived insights immediately   
• Modularity: flexible adaptation of smart factories to changing requirements by replacing or expanding individual modules.

Bledowski has suggested that the origins of the idea are to be found in the German government’s 2006 High Tech Strategy. Some of the features of Industry 4.0 were identified in Germany’s industrial policy in 2010 and in 2012 the government made Industry 4.0 one of 10 future projects part of its High-Tech Strategy. A working group consisting of representatives from industry, academics, and science was set up by the German Ministry of Education and Research which in 2013 published a final report outlining 8 priorities of an Industry 4.0 strategy ranging from standardisation to continued learning. The Ministry of Economics stated the goal of fostering research and innovation “at a precompetitive stage” and accelerating the process of transferring scientific findings into the development of marketable technologies. That this not only concerns large corporations becomes clear when the strategy explicitly includes the goal of strengthening the innovation power of entrepreneurs and SMEs by creating competence centres for Industry 4.0. The German government has since institutionalised its commitment to Industry 4.0 by setting up a platform led by Ministries of Economy and Research bringing together representatives from business, science, and the trade unions. The Industry 4.0 platform has divided up its main areas of focus across five different working groups: Reference Architecture; Standardisation; Research and Innovation; Networked Systems Security; Legal Environment; and Work, Education/Training. The platform issued a first report in April 2015. This report introduced the utility of Industry 4.0 to the wider economy and society as one of the key aspects to be further explored in the future and outlined a more refined research roadmap until 2030. This time horizon shows that Industry 4.0 is a very long-term strategy and the transformation it seeks to foster is still in embryonic form.

Industry 4.0 is not the only term that describes these new phenomena in industrial production. As mentioned above, both the Internet of Things (IoT) – a term coined in 1998 – and the Internet of Services describe the digital integration of production and services.  
 • The Internet of Things: refers to IT systems connected to all sub-systems, processes, internal and external objects, supplier and customer networks; that communicate and cooperate with each other and with humans. According to some estimates, the number of devices communicating with each other has surpassed the number of people communicating with each other. According to other projections, by 2020, 30 billion devices – from a jet liner to a sewing needle – will be connected to the internet.

(http://www.europarl.europa.eu/RegData/etudes/STUD/2016/570007/IPOL\_STU(2016)570007\_EN.pdf)

• The Internet of Services: refers to internal and cross-organizational services which are offered and utilised by participants in the value chain and driven by big data and cloud computing. Industry 4.0 is application of the IoT into a manufacturing and service environment. Some other terms often cited in the literature concerned with Industry 4.0 are:   
• The Industrial Internet: General Electric describes similar phenomena to those summarised under Industry 4.0 as the ‘Industrial Internet’ (II) in which the industrial and the internet revolutions come together. The difference here is that unlike Industry 4.0, the Industrial Internet goes beyond manufacturing to cover the wider adoption of the web into other forms of economic activity.  
• Advanced manufacturing: Another term often cited in the literature to describe innovations in technology improving products or processes.   
• Cyber-physical systems which are made up of software embedded in hardware such as sensors, processors and communication technologies and can autonomously exchange information, trigger actions and control each other independently.  
• Smart factory: This and the related term ‘factory of the future’ exemplify some of the technical innovations under Industry 4.0 such as integration of ICT in the production process and how these could play out in practice.

(<https://www.tibco.com/solutions/industry-40>)

**Exactly How Many Industrial Revolutions Have We Had?**

If you haven’t been paying much attention to the last century of industrial history, you might be forgiven for thinking that we’ve only had the [one revolution](https://www.engineering.com/AdvancedManufacturing/ArticleID/16176/Was-the-Industrial-Revolution-Really-Worth-it.aspx): in the time period between 1760 and 1840. This represents the transition from skilled artisans making goods by hand to (relatively) unskilled workers using machines powered by a water wheel or steam engine. The transition was most prevalent in the textile industry, but the effects of the first industrial revolution were eventually felt in almost every aspect of daily life.

That was Industry 1.0, and we’re on our way to Industry 4.0, so what about versions 2.0 and 3.0?

The second industrial revolution took place over the end of the 19th century and beginning of the 20th from about 1870 to 1914 and the beginning of World War I. Unlike the first industrial revolution, which was characterized by the advent of new technologies, the second industrial revolution had more to do with improving existing technologies and the synergies between them.

For example, electricity replaced water and steam as the primary power source in factories. The second industrial revolution also marked the beginning of the assembly line, interchangeable parts and, with them, mass production.

The third industrial revolution, like the first, saw the introduction of disruptive new technologies—in this case, automation and the computer. These advancements brought about monumental changes to manufacturing, enabling levels of precision (thanks to industrial robots) and accuracy (thanks to Computer Numerical Controls (CNCs), never before seen on the shop floor. Pinpointing the time period for the third industrial revolution is tricky, because—at least on some accounts—we’re still in it, but the beginning can be traced to the early 1960s, which saw the introduction of the first industrial robot and first commercial CNCs.

|  |  |  |
| --- | --- | --- |
| **Industrial Revolution** | **Time Period** | **Core Aspects** |
| 1.0 | 1760 – 1840 | Mechanization |
| 2.0 | 1870 – 1914 | Mass Production |
| 3.0 | 1960 – 20?? | Computerization |
| 4.0 | Now? | - |

The odd-numbered revolutions were the apparent result of disruptive new technologies, e.g., the steam engine or computer. In contrast, revolution 2.0 had less to do with the invention of new technologies than with enhancing the synergy between them. If the pattern holds, we should thus expect Industry 4.0 to involve more optimization than invention.

Granted, this inference is based on a paltry sample size (and we can’t exactly run simulations or controlled experiments with industrial revolutions), but it does have some support within the industry, as Jason Urso, CTO for [Honeywell Process Solutions](https://www.honeywellprocess.com/en-US/pages/default.aspx), explained:

“We invented digital control systems 35-40 years ago for the purpose of connecting tens of thousands of sensors to a digital control system. So, 35 years ago, we started the journey toward the Industrial Internet of Things [IIoT].

“If I look at the next major generational shift that occurred, it was probably in the early 2000s timeframe, with the advent of open systems and more advanced applications. Building a suite of software on top of existing control systems allowed us to make even better use of all the data that had been collected in the control systems from those tens of thousands of sensors and actuators within the four walls of the plant.

“That created yet another wave of significant benefits for our industry. I think we’re now in this next wave, which is often called Industry 4.0, but I see it as building upon those prior steps.”

Urso is describing a popular view regarding Industry 4.0 and social/economic revolutions in general, i.e., they occur gradually over a long period of time. That’s why you’ll often hear experts reframing the concept of a fourth industrial revolution in terms of a fourth industrial *evolution*. The claim is not that there are no great leaps in manufacturing technology, but rather that their impact takes time to be felt across the entire sector.

(<https://www.engineering.com/AdvancedManufacturing/ArticleID/16521/What-Is-Industry-40-Anyway.aspx>)

### Smart Factories of Industry 4.0

The smart factory, also sometimes called “the factory of the future” is the keystone of the fourth industrial revolution. Indeed, it’s often represented as the aggregate of all the Industry 4.0 technologies: cyber-physical systems—physical assets connected to digital twins—the Industrial Internet of Things (IIoT), data analytics, additive manufacturing and artificial intelligence.

But what does that actually look like?

How will the smart factories of Industry 4.0 differ from the “dumb” factories of Industry 3.0?

“If a factory is producing a quality product, the processes are tuned, the supplier channel is correctly monitored and everything is running like a well-oiled machine,” Martin said. “I think that factory today and the factory of the future are, quite frankly, going to look very similar.”

This goes back to the point about Industry 4.0 being more about optimization than invention, as Martin explained: “The reality is that it’s very seldom for any factory to work like a well-oiled machine. If you walk into a factory today, what do you see? A group of engineers huddled around a problem, brainstorming. ‘What is this? How did it happen? What the hell do we do to fix it?’ In the factory of the future, you’re going to see a computational database spitting out not just, ‘Hey, you have a quality problem,’ but ‘Hey, here’s the solution to your problem,’ and, hopefully, in the larger scope of things you don’t even see it.”

Urso agreed that optimization is the watchword for Industry 4.0, emphasizing the role that big data analytics will play.

“If you think about it in the medical industry,” he explained, “a doctor gets really skilled by seeing many patients over a long time. That enables them to build a strong mental model about what symptoms lead to what medical condition. And that’s what we’re doing: trying to increase the number of patients we’re seeing.”

However, rather than increasing instrumentation inside individual facilities, the key is to improve the interconnections between separate facilities, as Urso explained:

“We have pretty significant instrumentation already, given the first wave of technology that was introduced with digital control systems, but the problem was that the data was always encapsulated within the four walls of a plant. Allowing that data to come to a central repository—in a cloud environment, for instance—where it can be shared across many plants is what gives us an advantage. That, to me, is what Industry 4.0 is all about.”

(https://www.boschrexroth.com/en/xc/trends-and-topics/industry-4-0/connected-industry-1)s

**Internet Of Things (IoT)**

The Internet of Things (IoT) is a novel paradigm that is rapidly gaining ground in the scenario of modern wireless telecommunications. The basic idea of this concept is the pervasive presence around us of a variety of things or objects – such as Radio – Frequency IDentification (RFID) tags, sensors,

actuators, mobile phones, etc. – which, through unique addressing schemes, are able to interact with

each other and cooperate with their neighbors to reach common goals. According to Cluster of European research projects on the Internet of Things. „Things‟ are active participants in business,

information and social processes where they are enabled to interact and communicate among themselves and with the environment by exchanging data and information sensed about the environment, while reacting autonomously to the real/physical world events and influencing it by running processes that trigger actions and create services with or without direct human intervention.

According to Forrester, a smart environment is: Uses information and communications technologies to make the critical infrastructure components and services of a city‟s administration, education, healthcare, public safety, real estate, transportation and utilities more aware, interactive and efficient.

(<https://www.researchgate.net/publication/282791888_Smart_factory_for_industry_40_A_review> [accessed Apr 15 2018])   
(*Smart factory for industry 4.0*)

**Internet of Things, RFID**

Roughly speaking, the Internet of Things means a worldwide network of interconnected and uniform

addressed objects that communicate via standard protocols. In such networks, a large number of devices (heterogeneous) present a unique address for data exchange, which is a difficult problem. The solution to that, many see in the use of semantic technologies, which have inspired the third, semantic set of definitions. Radio frequency identification (RFID) was conceived as a simple replacement of bar codes where the product identification is carried out wirelessly via radio waves. By using such a system certain restrictions that exist in the use of bar codes are removed, such as for Eg. The need for direct visibility of the code by the reader, a small distance at which it can be read, the problems

with damaged labels with bar codes, slowness in reading more quantity of products etc. Active RFID readers have their own battery power and can initiate communications. From multiple applications the main application of the active RFID tag is in port for containerized cargo tracking. The main segments of RFID systems RFID tags, RFID reader and a computer. RFID tag is a carrier of product, such as a bar code. It consists of a memory chip and a transmitter that communicates with the RFID reader. RFID technology has some great advantages and disadvantages with respect to the bar code. Products marked with RFID tags can be read even in cases when they are not directly accessible to the reader. Data can be read from a distance up to 10 meters. Speed of reading is very large, so that in one second

can be read hundreds of tags. Unlike bar codes, which can easily be damaged and thus lose information, RFID tags are highly resistant to physical damage. In the RFID tags corresponding species subsequently, the necessary information may be added. Unlike the bar code technology, which is cheap, the RFID technology is significantly more expensive. Since it is based on radio waves, suffers from a lack of radio communication: radio waves misbehave in humid conditions, in the presence of higher amounts of metals in the environment and in the presence of "electronic noise". A variety of data that neds to encode in RFID tags causes more expensive products because of the need to make bigger memory chips. This increases the time required for reading and transferring data. In subsequent recording of information in RFID tags is necessary to provide security mechanisms to prevent the recording of false information by unauthorized persons.

Výše uvedený článek byl využit z portálu *www.businessinsider.com* -  
(<http://www.businessinsider.com/what-is-the-internet-of-things-definition-2016-8>)

**Passive Tags**  
Passive tags are the most prominent tag in use within RFID today. In general they are the most simple in design. The tag does not contain a battery, and depends on the strength of the reader RF signal to cause the tag to generate a response. In general, the passive tag contains a serial number, typically 96 to 128 bits in length. The serial number will most often be just a serial number with no connection to a particular product or application. The serial number can be read and then used to establish a relationship to a product within an application data base.

(https://www.engineering.com/ElectronicsDesign/ElectronicsDesignArticles/ArticleID/7196/What-Is-an-RFID-Tag.aspx)

**References**

1)

https://www.researchgate.net/publication/282791888\_Smart\_factory\_for\_industry\_40\_A\_review  
*Smart factory for industry 4.0: A review (PDF Download Available)*. Available from: <https://www.researchgate.net/publication/282791888_Smart_factory_for_industry_40_A_review> [accessed Apr 15 2018].

2)

<https://www.forbes.com/sites/riverbed/2018/03/14/leveraging-software-defined-technology-to-drive-a-successful-infrastructure-refresh/#31c5d8ed2173>

3)  
https://www.boschrexroth.com/en/xc/trends-and-topics/industry-4-0/connected-industry-1

4)

<https://www.engineering.com/AdvancedManufacturing/ArticleID/16521/What-Is-Industry-40-Anyway.aspx>

5)  
<http://www.europarl.europa.eu/RegData/etudes/STUD/2016/570007/IPOL_STU(2016)570007_EN.pdf>

6)  
<https://www.tibco.com/solutions/industry-40>

7)  
<https://www2.deloitte.com/insights/us/en/focus/industry-4-0/overview.html>

8)  
<http://www.businessinsider.com/what-is-the-internet-of-things-definition-2016-8>

9)  
(<https://www.techradar.com/news/what-is-industry-40-everything-you-need-to-know>)

10)  
(https://www.engineering.com/ElectronicsDesign/ElectronicsDesignArticles/ArticleID/7196/What-Is-an-RFID-Tag.aspx)